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By Mama SANGARE, K. BERTHE, I. TRAORE & O. K. BAGUI
Institut des Sciences Appliquées

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The aim of this research is the study of effects caused by weeds according to the phenomenon of photosynthesis influencing the yield of fields of rice and vegetable crops. The multispectral transmission, reflection, and scattering microscope has been used for image acquisition in the ultra-violet to the near-infrared band.

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Photosynthetic Study of the Effects of Some Weeds in Rice and Vegetable Fields by Spectroscopic and Multimodal Technique in Yamoussoukro (Ivory Coast)

Mama SANGARE [α], K. BERTHE [σ], I. TRAORE [ρ] & O. K. BAGUI [ω]

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Through the microscopic images obtained, the average intensities of the pixels of an area of the image have been evaluated to reconstruct their corresponding spectrum to proceed with a study of their wavelength-by-wavelength optical property. The results obtained by the adopted multimodal technique highlighted the influence of weeds on rice and vegetable plants in the ultraviolet, visible, and near-infrared range in Yamoussoukro in Côte d'Ivoire; also estimating their chlorophyll level at specifique wavelengths.

The development of spectroscopic and multimodal analysis methods has mainly contributed to the diagnosis of certain weeds, which are; among others, *Boerhaviadiffusa*, *Echinochloastagnina*, *Mimosa pigra L.*, *Euphorbia heterophylla*, *Perotisindica*, *Lepto-chloacarulescens*, *Imperata cylindrical*, and *Cassia Mimosoideae*.

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I. Introduction

In the Ivorian food security policy, agriculture is a challenge in sight to respond to the needs of interior consumption [1]. In recent years, studies of pest and agronomic control methods against weeds have focused on the Ivory Coast between 1968 and 1980 [2].

Author α: Laboratoire d'optique, de Spectroscopie et des Sciences de l'atmosphère, Institut des Sciences Appliquées, ISA-USTTB, Mali.
e-mail: mamasangare101186@gmail.com
Author σ ρ: Laboratoire d'optique, de Spectroscopie et des Sciences de l'atmosphère, Faculté des Sciences et Techniques FST-USTTB-Mali
Author ω: Laboratoire d'Instrumentation Image et Spectroscopie, Institut National Polytechnique Felix Houphouët-Boigny Yamoussoukro, Cote d'Ivoire.

As a result, weeds have been poorly controlled due to their abundance and resistance in crop fields despite the efforts of other researchers [3, 4, 5]. These constitute a threat on the most rice and vegetable crops. The preventive measures adopted by microbiologists and agronomists require other complementary studies based on optical spectroscopy to eradicate these devastators.

Thereby, the establishment of research to improve weed detection tools are needed to develop new control methods. Moreover, to achieve the objectives of sustainable development to improve the yield of the crop production in Africa, particularly in developing countries, optical spectroscopy is considered one of the most promising recent techniques; to effectively prevent and control weeds and other various pathogenic diseases that may slow down the harvest of farmers' fields. Optical spectroscopy, already in use in some African countries for several years, has been the object of medical diagnosis through agriculture [6].

However, the application of optical spectroscopy on weeds rests a multidisciplinary study undeveloped by scientific researchers in Ivory Coast and elsewhere. Thus, to limit the impact of weeds on agricultural production, effective collaboration between local and external researchers has been necessary to carry out this scientific work. It is within this framework; the present research project has been carried out by the Institute of Applied Sciences (ISA) of Bamako-Mali, the Faculty of Sciences and Techniques (FST) under cover of the University of Technical Sciences and Bamako Technologies (USTTB) and the National Polytechnic Institute Félix Houphouët Boigny (INP-HB) Yamous-soukro/Ivory Coast; to achieve the desired objective.

The technique developed has been used to carry out a photosynthetic study of the optical properties of certain weeds in transmission, reflection, and diffusion mode and their micro-spectroscopic spectra from measurements by multispectral microscopy in any culture medium tropical all over Africa. The goal is to show the innovation of our technique to characterize the different weeds in the fields of rice crops and those of vegetable crops and making a study of their effect from the spectral data of the microscopic components in terms of concentration in chlorophylls.

II. Methodology and Materials used

a) Sampling

In a field of crops in Yamoussoukro, the sampling took place to the north and in lowland to the south of the Institut National Polytechnique Phélix Houphouët Boigny (INP-HB) by selecting certain weeds likely to cause effects on market garden plants and rice crops. The field trip has been supervised by the Plant Pathology and Biology Laboratory of the INP-HB. During this prospecting, eight (8) samples have been collected, including six samples of selected weeds attacking market garden plants (*Boerhaviadiffusa*, *Mimosa pigra L.*, *Perotisindica*, *Leptochloacarulescens*, *Imperata cylindrical*, and *Cassia Mimosoideae*) and two samples of weeds attacking rice crop fields (*Echinochloastagnina* and *Euphorbia heterophylla*).

b) Methodology and strategy for data analysis by multimodal spectroscopy

The data acquisition system is described in [7, 8]. The classique light sources have been removed and replaced for all modes by a set of 13 LEDs with wavelengths ranging from 375nm to 940nm. The initial mechanical eyepieces are substituted by a 12-bit CMOS monochrome camera (2592x1944, Guppy - 503B, Vision Allied Technology, with an MT9P031 micron / Aptina sensor), with a pixel size of 2.2 μm x 2.2 μm, which has been used to acquire images.The system automatically obtain a total of 39 spectral images (13 images per mode) for the same scene, using a data acquisition card (NI-DAQ) coupled to a computer, which controls the current intensities for fine adjustments.

In addition, the transmission, reflection, and scattering modes are used to acquire microscopic images of each of the weeds collected according to the location targeted for sampling. The thirteen light sources are sufficient to study the optical properties of biological cells [7]. Depending on the study method, the spectra correspond to the microscopic images of the samples obtained from the Yamoussoukro / Ivory Coast.

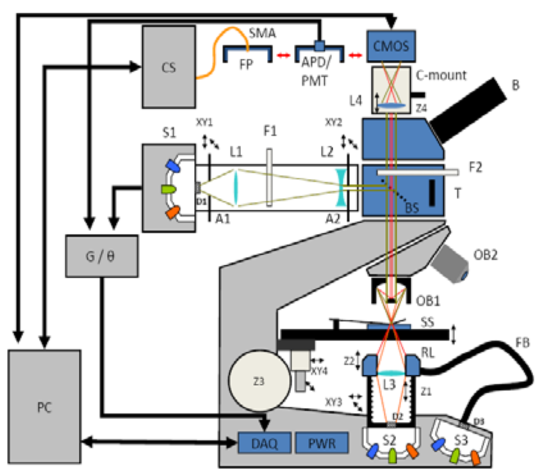

Figure 1: Photo image of the multispectral microscope

Through the images acquired of each of the sorted weeds by the multispectral microscope, the most rudimentary technique used to extract of multiple mean spectral signatures as a function of wavelengths in transmission mode, reflection mode, and scattering mode is the technique of multimodal spectroscopy analysis.

Microscopic and multimodal measurements have made between ultraviolet and near-infrared.

The transmission, reflection, and scattering spectra representative of the weed leaves areextracted after appropriate treatment of the images with the "Matlab" software.The spectra obtained represent the average distributions of the intensities transmitted, reflected, and diffused by the leaf samples of each weed (Figure 3, 4, and 5). The flow chart of the methodology is summarized as follows (Figure 2).

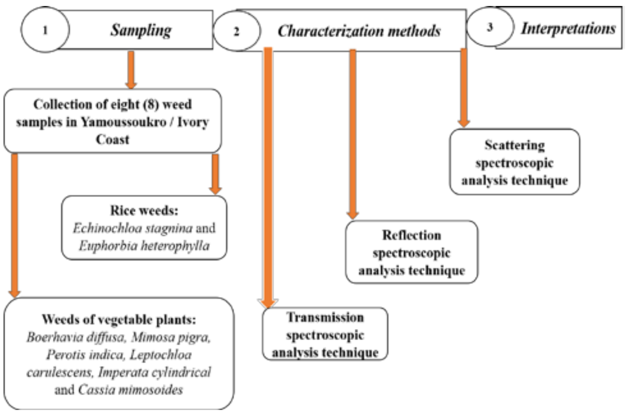

Figure 2: Methodological flowchart

III. Results And Discussion

After the data analysis, figures 3, 4, and 5 are the results obtained for each study mode according to the thirteen wavelengths ranging from ultraviolet to near-infrared.

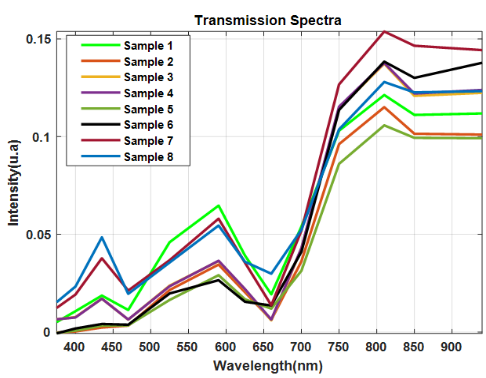

Figure 3: Average spectra of samples collected in transmission (1: *Boerhaviadiffusa*; 2: *Echinochloa Stagnina*; 3: *Mimosapigra L.*; 4: *Euphorbia heterophylla*; 5: *Perotisindica,* 6: *Leptochloacarulescens,* 7: *Imperata cylindrical and* 8: *Cassia Mimosoideae*).

The spectral distribution of the different transmission weed species (Figure 3 above) constitutes those that are likely to generally attack rice crop fields, and market garden plants in Yamoussoukro.They transmit quantitatively less UV and visible light (between 375 nm and 660 nm) in terms of intensities. It is in the visible radiation stage that photosynthesis unfold, carrying away some nutrients necessary for the plant leaves. However, the spectroscopic study in the same bands certifies that the sorted weeds behave similarly to a healthy leaf [9]. Hence, it is often difficult to visually differentiate weeds from certain crop plants (rice fields, for example).

In addition, a leaf that transmits less visible light absorbs a sufficient amount of chlorophyll,playing the process of photosynthesis to provide more nutrients to crops. Thus, the effect of these weeds has not to influence on rice crops and vegetable crops; hence they resist better by strengthening these cultures.

On the other hand, these same species transmit the maximum infrared wavelength with an insufficient concentration of chlorophyll to not effectively play the phenomenon of photosynthesis. That often causes yellowing and wilting of these weed species by attacking rice leaves and vegetable plants in fields.It is also to consider that their rate of chlorophyll concentration varies from one electromagnetic radiation (UV-Visible) to another (Near-Infrared) to play probably appropriately the phenomenon of photosynthesis using light energy. Among the weeds studied by our transmission multispectral imaging method, *Leptochloacarulescence* and *Perotisindica* have practically no influence on vegetable plants because of their high amount of chlorophyll for photosynthesis because they absorb more electromagnetic light ranging from ultraviolet to visible (375 nm to 700 nm) than they transmit in terms of intensities.But, *Imperatacylinchical* (sample 7) is considered one of the most dangerous weeds among those studied in Yamoussoukro because it transmits the maximum infrared light ranging from 660 nm to 940 nm.

Compared to the weeds *EchinochloaStagnina* and *Euphorbia heterophylla*, which influence rice crops, the spectroscopic study suggests that only *Euphorbia heterophylla* transmits less visible light during photosynthesis in a field of rice cultivation;thus, its presence will not affect on the evolution of rice.

Nevertheless, spectroscopic analysis shows that the weeds selected in our study have peaks characteristic of a healthyleaf at 660 nm with variable behavior playing the role of photosynthesis in rice and vegetable fields.Thus, despite the degree of influence of these weeds on the sampled fields, it is likely to have a good harvest depending on the growing environment.

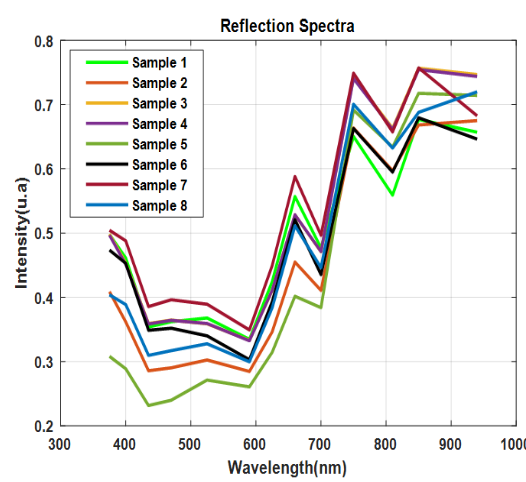

Figure 4: Average spectra of samples collected inreflection (1: *Boerhaviadiffusa*; 2: *EchinochloaStagnina; 3: Mimosapigra L.; 4: Euphorbia heterophylla*; 5: *Perotisindica,* 6: *Leptochloacarulescens,* 7: *Imperata cylindrical and* 8: *Cassia Mimosoideae*)

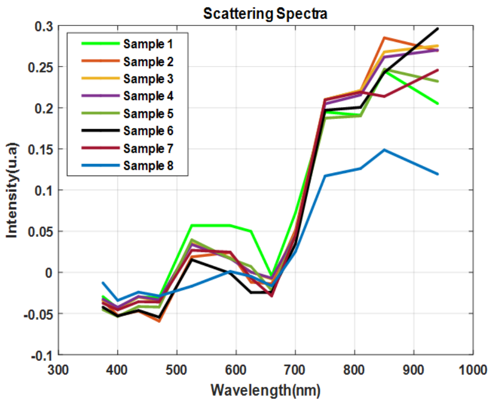

Figure 5: Average spectra of samples collected in scattering (1: *Boerhaviadiffusa*; 2: *EchinochloaStagnina*; 3: *Mimosapigra L.*; 4: *Euphorbia heterophylla*; 5: *Perotisindica,* 6:*Leptochloacarulescens,* 7: *Imperata cylindrical* and 8: *Cassia Mimosoideae*).

In reflection and diffusion, it is also to notice that these same weed species selected in Yamoussoukro reflect and scatter more ultraviolet (375 nm), visible (400 nm-700 nm) radiation than infrared (Figure 4 and 5).On the other hand, the amount of reflected light depends on what has been absorbed by the weeds.The green coloration of the leaf is a function of the degree of absorption of red light to provide the reaction of photosynthesis, at the same time, near-infrared radiation (700nm-940nm) have fully reflected or transmitted [10, 11, 12]. In this case, the spectral study of these weeds shows that they absorb the maximum of chlorophylls (a and b) to capture ultraviolet and visible light.Generally, photosynthesis does not realize in the absence of light radiation. Thus, their chlorophyll level is sufficient to receive and convert the sun's energy into certain nutrients for healthy rice growth; because some of these defense mechanisms can help save water. That is why some species of weeds stay alive to a new culture.Thus, for anwell harvest, spectroscopic information from the multimodal analysis of these weeds isimportant for growers and essential to properly monitor their behavior in crop fields.

IV. Conclusion

This research project has been realized in collaboration with other researchers, members of the Plant Pathology, and Biology Laboratory at INP-HB and the Image and Spectroscopy Instrumentation Laboratory at INP-HB.

It has been proved in this study that the reaction of weeds depends on their optical properties and the growing environment.Optical spectral analysis provides powerful insight into the biochemical content of weed samples in a wide variety of applications.

Thanks to spectroscopic techniques; the effects caused by weeds influencing the yield of rice and other vegetable crops have been studied, thus estimating their chlorophyll levels through their spectral variation in terms of transmitted, reflected and scattered light intensities.The results obtained show the potential of the proposed technique; to further facilitating the struggles of agronomists, and the biochemical analyzes in laboratories for the diagnosis of weeds in crop fields to improve agricultural production.

An added value, the scientific contribution of this research project is a complementary study on weeds in Côte d'Ivoire and elsewhere using spectroscopic and multimodal techniques, this subject is not sufficiently developed in Africa.

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